

## ARIANE 5 VERIFICATION AND ASSOCIATED TEST FACILITIES

M. Vedrenne and A. L. Gonzalez  
ESA Headquarters - Paris

ABSTRACT

The philosophy of verification tests of the Ariane 5 launcher programme is already established. It corresponds to the development and the ground and flight qualification phases for both unmanned and manned launches. The different types of test are outlined for the system, booster, main core and upper structures, allowing the identification of the associated test facilities which are then described.

INTRODUCTION

The development of the Ariane 5 launcher is now beginning but a preliminary phase has been performed to establish the basis of both a sound configuration as well as its verification programme. A major part of this verification programme concerns testing and due to specific facilities foreseen and long delivery times, an early definition has been established.

In this paper, the test programme of the Ariane 5 is presented. First the tests classification is established to mention briefly the different tests proposed in each area and in a second part the test facilities are identified.

ARIANE 5 TESTING

The launcher tests can be classified with respect to their programmatic objectives in the following categories:

- Environmental definition (external, internal)
- Development
- Qualification

Alternatively, tests can be classified in relation to the launcher assemblies, giving the following groups:

- System
- Booster
- Main core
- Upper stage and structures

This second classification is used in the following descriptions making reference to the programmatic objectives involved.

## SYSTEM TESTS

The following system tests are foreseen:

Reduced Scale Tests

The purpose of these tests is to define the external environment of the launcher: Aerodynamic, thermal and acoustic tests are included. They are performed with reduced models in appropriate existing facilities.

## Functional Tests in Europe

The main objectives are in the development and qualification of the launcher guidance and control functions. To run these tests a functional simulation installation (ISF: Installation de Simulation Fonctionnelle) will be set up at Les Mureaux near Paris.

## Structural Tests

They will include the dynamic testing of the booster, main core and upper structures. The dynamic tests of the booster will be performed in the French Guiana test installations (see booster testing below). For the dynamic testing of the main core a specific facility will be installed in Europe.

## Validation Tests in French Guiana

Mechanical integration of the launcher as well as electrical verifications will be performed in CSG (Centre Spatial Guyanais).

## **BOOSTER TESTING**

The booster testing comprises: Preliminary tests; Testing in nominal the configuration.

The preliminary tests will allow evaluation of the different technologies to be used, manufacturing process, functioning aspects like internal pressure build up behaviour, segment joints, etc. . . . Different types of models will be used, some of them being at reduced scale and using teststands.

Ten firing tests will be performed in nominal configuration in the test facilities prepared in CSG. Three types of tests are to be distinguished.

### Tests B

The purpose of two tests is to evaluate the internal functioning with a reinforced structure to avoid the inherent risk of using a non fully developed structure.

### Tests M

These tests correspond to the development of the integrated booster. Four tests are foreseen, the first two will be used to verify the compatibility between the different elements of the booster. The other two will examine extreme environmental conditions.

### Tests Q

The functioning of the booster will be verified in four tests. The last two being associated in the same configuration as are the two flight units for the same launcher.

## **MAIN CORE TESTING**

Testing of this stage is broken down as follows:

- Tank
- Adjacent structures
- Engine
- Stage

The tank testing includes the usual verification of materials, technologies, manufacturing processes, functioning aspects of the anti-vortex, etc. . . .

For the adjacent structures, the tests are also the standard static and dynamic ones.

The engine in itself follows its own development sequence and a detailed description of its test plan is out of the scope of this communication. It should be mentioned in general terms that the engine testing started with the materials and processes verification followed by series of tests at components and subassemblies level to finally test the whole engine. A general description of the teststands will be found in the next section.

The complete stage will be tested in French Guiana, using the operational facilities: Launch integration building, transport platform and launch pad. It will be tested in launch configuration supported by two dummies representing the boosters.

## UPPER STAGE AND STRUCTURES TESTING

The upper stage follows at its level, the same testing logic as the main core: tank, structure, engine and stage testing. The teststands will be described below.

The upper structures comprise the vehicle equipment bay, the SPELTRA (Structure Porteuse Externe de Lancement Triple Ariane) (Structure allowing multiple launches) and the fairing. As for any structure, the main tests will be:

Static Tests: stiffness, strength

Dynamic Tests: vibrations, acoustic, separation

## ARIANE 5 TEST FACILITIES

It is too early in the programme to describe the test facilities, but the most important have already identified and a short description will be given in this section.

### BOOSTER TESTSTAND ZONE

This facility will comprise a test area with flues, a shelter structure including the technical premises and access facilities and mobile cover of the whole area; a mobile part made up of a pallet and the booster would be inserted in a solid metal structure integral with the foundations and having the handling facilities necessary for table/rail track levelling adjustments. A test monitoring zone about 700 m away, housing the monitoring and command facilities necessary for carrying out the tests and an access rail track linking the booster integration building to the teststand and enabling the whole mobile structure (pallet plus booster) to be transferred.

### MAIN CORE ENGINE TESTSTANDS

The engine testing involves many stands. Among them we can find the following ones:

Stand for testing components under high-pressure propellant (Vernon - France) to be used for characterization of the generator injection elements, dynamic seals and bearings.

Stand for testing the generator and oxygen turbopump (Ottobrunn - W. Germany). Adaptation of an existing stand.

Turbopump teststand (Vernon). The corresponding tests will be made on the liquid oxygen and liquid hydrogen turbopumps fed either independently from a high-pressure gaseous hydrogen source or a gas generator fed by high-pressure tanks or coupled with the gas generator fed with propellants tapped at the pump outlets.

Chamber teststand (Lampoldshausen – W. Germany). This stand will allow characterization and qualification tests of the engine combustion chamber in a horizontal position to be carried out. The chamber will be fed from high-pressure cryogenic tanks.

Engine stands (Vernon and Lampoldshausen). Both stands will be identical. They will be designed to simulate as closely as possible propellant and fluid system of the stage and to carry out tests in “stage with battleship tanks” configuration.

## UPPER STAGE PROPULSION TEST FACILITIES

Tests on the engine and the propulsion unit will be done on the test site at Lampoldshausen. This site has various facilities where cold tests can be carried out for the purpose of tuning, pressure testing and functional testing on the components of the engine and the propulsion unit. The hot tests will be carried out on the following teststands:

- Stand to be used for short-duration chamber and engine tests under ground conditions. The tests could be performed with or without a supersonic diffuser.
- Stand to test the propulsion unit and the integrated stage under ground conditions.
- Stand fitted with a vacuum chamber and a stream ejector, thus making it possible to run engine tests under vacuum conditions.

## SUMMARY AND CONCLUSION

The Ariane 5 launcher development is starting. From the preliminary phase, the verification tests corresponding to the launcher system, booster, main core, upper stage and structures, have been identified, allowing the preliminary definition of the test facilities needed. Among them, the booster teststand in French Guiana and the stands for testing the main engine and the upper stage engine have been outlined.